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# IMPACT OF MULTIMODAL CHOICE ON ANY ORGANISATION'S SUSTAINABLE SUPPLY CHAIN STRATEGIES

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***ABSTRACT***

***This paper explores on the impact of multimodal or intermodal choice on any organisation's sustainable supply chain strategies. It is a phenomenological approach in nature of very subjective to interpret data. This paper is academic research based on the multimodal choice when chosen global suppliers with triple bottom line theory, cost distance model and trade-offs to substantiate the findings.***

***This paper explores to provide an idea of the existing research and suggest potential chances for academic enquiry in connection to the operations management.***

***Design/Methodology Approach-***

***The researchers review the existing literature at the mind of the global transport modes options in any organisation. This literature links up to transport modes system in to assist in reviewing the multimodal choice in the current state global market of all disciplines of transport modes (road, rail, air, sea and pipeline). Suggestions have been made for future research in terms of the best modal option.***

***Findings***

***The findings show that the existing literature is mostly based on transport modes system without any application approach of the choice of modes. In addition, the findings suggest on the best option of the global transport modes that could adopted in any organisation sustainable supply chain strategies. The findings pointed out several strategies areas when selecting transport modes for cost advantage for future inquiry.***

***Practical Implication***

***This paper can be used by transport, logistics, supply chain and procurement professionals in every organisation as well as business that leads into import and export.***

***Originality/Value***

***This paper build on our knowledge on impact of multimodal choice on any organisation's sustainable supply chain strategies as it relates to key dimensions of triple bottom line ideology that had been previously used in literature to support the exiting literature in the paper and identify research opportunities for trade-offs.***

***KEYWORDS: Multimodal Choice, Road, Air, Sea, Rail, Water And Pipeline, Sustainable Supply Chain Strategies & Trade-Offs***

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## INTRODUCTION

This paper aims to critically evaluate the impact of multimodal or intermodal choice on any organisation's sustainable supply chain strategies. With regards to the aim, some key areas will be addressed, hence, forming the structure of this paper. The first section will concentrate on intermodal or multimodal choice when choosing to select global suppliers. However, modal choice selection process will be predominantly be discussed which will focus on operational characteristics (externalities), transport mode characteristics, consignment factors, cost and service requirements as a process of selecting the suitable mode of transport in global. Therefore, operational factors (externalities) will be the predominant one and will critically evaluate why is more important for multimodal choice.

The second part will base on impacts of sustainable supply chain strategies as mentioned in the research topic on multimodal choice of transport modes and will further discussed how five traditional modes of transport link to multimodal in a global supply chain considering cost distance model. With that, Elkintong triple bottom line theory will be applied, in order to achieve sustainable global supply chain on transport modes as a strategy to be adopted.

The final part will explore on the key areas that will evaluate potential trade-offs involved in transport modes.

### Intermodal/Multimodal Choice

Global economy for the past 30 years has recognised the importance of flow of products for which only few are wholly or partly obtained locally (Straubeet al., 2010). Because of that, transportation decision on modal choice has critically considered global firm activities of logistics, as 20% total average transportation costs (Russell and Taylor, 2003). However, global competition has drastically changed the system in a way goods are produced and transported in a global(Cambra-Fierro and Ruiz-Benitez, 2009). It is noted that, transport has direct impact on global supply chain which the main purpose is to move goods from origin to final destination to the purchasing organisation (Holter et al., 2008; Grant et al., 2006).

By definition, transport is an arrangement of transport mode that is used to move specific quantity of products from its origin to final destination (Islam et al., 2013). Intermodal Freight Transport Committee defined intermodal freight transport as'' all shipments that employ more than one mode in a single through movement from origin to destination'' quoted in (Lyson and Gillingham, 2003; 552). Similarly, European Conference of Transport Ministers also defined intermodal transport as ''the movement of goods in one and the same loading unit or vehicles, which uses successively several modes of transport without handling of the goods themselves in changing modes'' quoted in (Rushton et al., 2010; 379). Multimodal transport can also be defined, as a way of using more than one transport mode, in a supply chain (Guide, 2008). All the terminologies above are synonyms, which multimodal will be focussed for the purpose of this paper as stated in the research when choosing global suppliers.

Lyson and Gillingham (2003), categorised traditional or principal modern transport modes into five sections namely road, air, sea, rail, water and pipeline. However, the issue of multimodal choice came as result of when one option of freight transport could not be feasible to use for the whole supply chain originating from different overseas countries for instance UK to China which necessitated a combination in order to give better services option in meeting customer needs (Islam et al., 2013). As a result of that, Lyson and Gillingham (2003) categorised integrated freight transport distribution systems into nine notably rail-road, rail- water, rail- pipeline, rail- air, road- air, road- pipeline, water-pipelines, water- air and air- pipeline. But, Ballou (1987) argued that, not all of them are practical and only some have gained little acceptance

in global transport business (Lyson and Gillingham, 2003).

The fundamental question is how best transport mode could be selected. Company success depends on the best process of selecting transport modes (Meixell and Norbis, 2008). The process for selecting the best transport mode on global suppliers, split into four major stages notably ''operational factors, transport mode characteristics, consignment factors, and cost and service requirements'' coupled with modal choice selection process (Rushton et al., 2010; 333). According to Rushton et al. (2010), operational factors have been considered as external factors that have direct distribution factor, customer features, physical product characteristics, and other logistics components whereas transport mode characteristics require to understand and assess because some of the transport modes are appropriate to certain types of operational factors than others while the consignment factors need to be understood in order to ensure that specific choice of mode is suitable. For the purpose of this paper more emphasis will be on the operational factors or externalities from modal choice perspective (Rushton et al., 2010). Supply chain professionals must know that operational factors of modal choice from nation to nation is of importance factors, considering the basic infrastructure in a particular country, export controls and licences, trade barriers, communications systems, financial institutions and services, culture and weather that are necessary included and which should critically be considered as it varies from country to country which influence the modal choice (Rushton et al., 2010). Considering the operational and inherent differential factors, there are big differences in the performance of various transport modes in a given country, and between the transport systems of different countries (Islam et al., 2013). Challenges that influence transportation choice involve international growth, capacity shortages, economies of scale, security issues, environmental and energy use concern (Meixell and Norbis, 2008).

**How do Traditional Modes Transport Link to Multimodal Option/Choice**

Traditional modes are incorporated or linked to the global supply chain as multimodal choice when one transport option cannot be possible to move goods from UK to China as said earlier (Beresford et al., 2011). Due to that, cost distance model need to be applied as a result of linking different combination of transport for national and global routes in global supply chain (Banomyong and Beresford, 2001). Owing to significant of multimodal transport in global trade purpose, several models have been designed to assist transport decision makers in selecting the suitable transport mode or combination (Christopher, 2005; Yan et al., 1995 cited in Beresford et al., 2011). Bullen (2004) suggests that, the decision of outsourcing can be efficiently dealt with thanks to a dozens of theoretical approaches (e.g., division of labor, co-ordination theory, transaction cost theory, core competence theory, unit of competitive advantage, power, agency theory, competitive strategy, resource-based theory, partnership, resource-dependency theory, game theory. The basic question is why an organisation should accept multimodal. Multimodal provides organisations a complete variety of modes of transport and routing options in order to coordinate supply effectively, finance, production storage and distribution functions to enhance efficient relationships with all members in the global supply chain (Rondinelli and Berry, 2000). The relationship between a transport buyer and provider can be characterized, as an agency relationship Logan (2000). Strategic decision in logistics management is, to choose the suitable multimodal option of transport, in order to move global firm inbound and outbound materials easily for cost benefit (Meixell and Norbis, 2008). The significance of the combination or multimodal is its availability of different routes or terminals choices that it provides and user ability to look for alternative because flexibility is a key determinant issue of modal options (Islam, et al., 2013).

Besides, decision making on selection the best transportation option of different modes is to reduce logistics costs, transit time and to maintain logistics service levels that can satisfy a lot of users requirement at the right time and risk that

can be solved by the adoption of the multimodal system (Bereford et al., 2011; Cambra-Fierroand Ruiz-Benitez, 2009; Meixell and Norbis, 2008). The idea of traditional modes linked to the multimodal, in global supply chain has enhanced multimodal, to assist in lowering transport costs, which allow each mode to be used for part of the journey to which it is more suited, increased of economic productivity and efficiency for national competitiveness purpose, reduction of congestion and burden of overstressed infrastructure components while at the same time reduces energy consumption for improved air quality and environmental conditions (National Commission on Intermodal Transport, 1994 cited in Lyson and Gillingham, 2003). However, apart from cost there is a high degree of reliability of service which account for the total reliability of the end customer of transport chain that matters because individual may have different reliability (Islam et al., 2013). uncertainty theory, which has been used to model system reliability design, project scheduling problem, vehicle routing problem and facility location problem. (Zhou and Liu. 2007)

It was further stated that multimodal lead to performance improvement of variety of modes as a result of economic, technology, political and institutional approaches to enhance total transport chain (Islam et al., 2013) and multimodal efficiency with regards to unique service for different global supply chain (Beresford et al., 2011).

**Impact of Sustainable Supply Chain Strategies on Multimodal Option**

For global transport solutions to be feasible it needs to integrate global supply chain (Potter, 2003). Sustainable supply strategies have been considered with regards to the triple bottom line thinking or ideology (Elkington, 2004; Carter and Rogers, 2008) see appendix 1. By definition, sustainability is ‘’using resources to meet the needs of the present without compromising the ability of future generations to meet their needs’’ (The World Commission on Environment and Development (WCED) (1998, quoted in winter and Knemeyer, 2013: 8). Global firms in economic outlook has designed plans, programmes and policies that will enhance their sustainability performance in multimodal perspective based on triple bottom line of social, economic and environmental performance (Elkington, 1997 referred in Glock et al., 2012). However, it was argued that companies focus more on economic and environmental dimensions of modes of transport rather than social dimension (winter and Knemeyer, 2013). It is also important; to understand how citizens perceive the sustainability of transport in their cities and how satisfied they are with the transport system and its effects on the environment and social issues. (Banister, 2008;Black, W. R.2010). With regards to the operational factors when selecting transport, much efforts and strategic proactive decision need to be adopted in order to balance the social, economic and environmental factors in achieving sustainability in modes of transport in order to respond to the idea of the triple bottom line(Elkington, 2004; Carter and Rogers, 2008; Pagell and Wu, 2009). Extreme weather events are real threats to the transportation system and one main element of transport disruption (Koetse, and Rietveld, 2009)

Organisation multimodal choice will determine the nature of the materials they produce, to transport for sustainability reason (Rushton et al., 2010). For instance, health sector supply chain in African countries either Ghana or Nigeria that deal with ordering of medicines and non- medicine consumables from overseas country like UK, China and United States. Transport modes or combination may include road or rail, air and sea which their impacts have been explained below in depth. The aforementioned organisation could consider road as relevant during dispatching goods for shipping and after the goods have arrived at the port to the final destination (Holter et al., 2008). When travellers entrust their choice for safe, reliable, comfortable and cheap transport, this creates a metaphorical contract, known as an agency contract (Anwar, et al2014). The benefit for global road freight transport is its regular services, quickest mode and flexibility of road scheduling (Rushton et al., 2010; Islam et al., 2013). With that, it allows to choose from variety of

commercial carriers which is not usually available by rail. It is one of the modes of transport that can offer door to door service in terms of short or medium transport haul without using other modes (Islam et al., 2013).

Rushton et al. (2013) further stated that, it is predominantly less costly in terms of complete unit loads with single origin and destination points, and also reduced double handling and tranship goods, while packaging led to less restriction and minimum cost, as a result of loads that are less susceptible to extreme transit shocks, unlike other modes. It drawbacks are as result of becoming costlier when distance are more than 500km transport haul (Islam et al., 2013). It also inherent low load capacities unlike rail and water transport modes, highly expensive in terms of environmental issue as a result of noise pollution, air, vibration, traffic congestion and road damage (Lyson and Gillingham, 2003).

Rail freight transport may be chosen by the above organisation where there is easy access to the manufacturer premise to move goods to port and after arrival to the final destination where possible which has immensely been used globally as being cheaper due to its capability of bulky and heavy consignments for movement over medium to longer distance as advantage (Rushton et al., 2013). It emits approximately 10% carbon dioxide as compared to its equivalent road freight and in terms of containers and wagons it provides relatively high security (Lyson and Gillingham, 2003). Its disadvantage is the requirement of double handle of large loads from the origin to the final destination through journey often requires by road transport Rushton et al., 2010). Further, due to limited number of railheads available at deports and factories, it is very rare when making direct journey. Furthermore, it is very slow means of carriage when considering the whole journey and very unreliable as a lot of wagons possible arrive at irregular intervals (Rushton et al., 2010).

Besides, air freight may be chosen by the aforesaid organisation for urgent shipments and perishable products of high value especially when patients need to be operated within the shortest possible time for specific medicines (Rushton et al., 2010; Lyson and Gillingham, 2003). Choosing air freight could lead to great deal market flexibility or marketing advantages, leading to reduction in total costs for some high value light goods (Rushton et al., 2010). The marketing advantages may arise through a combination of flexibility, speed and frequency coupled with the benefit of environment of high quality resulting to minimal damage, theft, loss and reductions in protective packaging requirements (Lyson and Gillingham, 2003; Rushton et al., 2010). However, those cost advantages of using air freight will emanate from lead time reduction leading to in transit inventory reduction, protective packaging and insurance rate (Lyson and Gillingham, 2003). Nevertheless, air freight is very expensive because majority of the products cannot afford especially to airport storage and despite of its quick from airport to airport, sometimes speed factor is diminished as time can be lost as a result of airport congestion, administrative issue, customs delays and handling (Rushton et al., 2010). Again, there is a current environmental factors issue on gaseous emissions and noise, restriction to move some specific goods by air for chemicals and dangerous products, size and weight and availability of aircraft (Lyson and Gillingham, 2003).

Additionally, the health organisation may choose deep sea freight especially for non- medicines consumable when orders are placed in advance as a low cost for economies of scale which particularly applied to bulk goods(high capacity) to large packed consignments for long distance (Rushton et al., 2010). With regards to container cargoes, it has high security and its adverse weather condition is very less, unlike air transport (Lyson and Gillingham, 2003). Notwithstanding the above advantages, sea transport is inherent with low speed, unlike air transport and also double handling normally occurred for short sea routes leading to damage of products and packing of cargo on conventional ships, delay problems leading to bad and irregular services (Rushton et al., 2010). Some of the delays may attribute to delays in pre-shipment, unexpected and discharge port delays and bad weather (Rushton et al., 2010).

Petroleum and natural gas supply chain from UK to Ghana for instance could include two combinations of pipeline, sea and back to pipeline in transporting their raw materials globally. Having explained sea freight above, selecting of pipeline is recognised as the best option of modes as a result of being safer, cost effective, very efficient and environmental suitable, fully automated system, free interference with human movement, very cheap to operate free from weather problems (Lyson and Gillingham, 2003). However, certain setbacks have been confirmed as highly costly in construction of pipelines at the initial stage and land disturbances and inflexibility in a situation, where pipelines are no longer needed (Lyson and Gillingham, 2003). Therefore, the five modes of transport become impacts to the stakeholders on social, economic and environmental factors so far as sustainability is concerned.

**Trade-Offs on Transport Modes**

Trade –offs between cost and service need to be considered in economic benefit that involve in the selection of transport modes as a final strategic decision for the benefit of the entire global firm (Rushton et al., 2010. In many countries, Cost-Benefit Analysis is used for transport policy appraisal (Mackie and Worsley 2013). According to Rushton et al. (2010), the aim must take into account the significant of operational factors, transport mode characteristics and consignment factors as discussed earlier. The authors however stressed that the relative costs in terms of choice of mode in theory is determined by the volume of freight to move and the distance to travel which modal choice matrix support this idea (see appendix 2). From the modal choice matrix analysis, there is a short distance that is advisable to use small parcel which is possible to pass through road transport or post. Alternatively, 100-tonne plus load travelling thousands of kilometres will possible require moving via sea transport. Whilst, speed of delivery required or service reliability may at times override economic factors in practice (Rushton et al., 2010). In considering speed of delivery, there may be an urgent need of orders (spare parts or perishable items) for reasons that override the cost factor whereas air transport is preferred to sea because of extra freight costs which can possible be balance against inventory savings, or availability of stock while service delivery is very significant as some customer service policies focussed on orders arriving customers are expected to meet tight delivery windows (Rushton et al., 2010).

In responding to the analysis in appendix 3, if environmental is the issue, then water and pipeline are the best options but will lead to low speed while in terms of availability and flexibility (economic) road is preferred but will trade-off to the environmental factors. With regard to speed air is good but will affect flexibility, dependability and capability. However, considering all the five transport modes in multimodal supply chain, road is the best option for trade-offs balance when selecting from the operating characteristics of speed, availability, dependability, flexibility and environmental factors (Lyson and Gillingham, 2003), in order to respond effectively to stakeholders impact of sustainable supply chain and demand (Narus and Anderson, 1996 cited by Rodrigue et al., 2008). It is believed that, there is the need to integrate economic, social and environmental on transport modes into supply chain management research and practice in reducing the negative impact of transport (Srivastava, 2007).

With reference to appendix 4, rail has low variable cost which will trade-offs high fixed cost while air fixed cost is low which will also trade-offs high variable cost whereas pipelines has low variable cost but high fixed cost. Similarly, road has low fixed cost but medium variable cost while water has low variable cost but medium fixed cost. From the analysis and by virtue of trade-offs, balancing fixed and variable cost of different transport modes sound more wisely and suitable to use road transport for medium or light loads while rail freight for heavy bulk loads (Lyson and Gillingham, 2003). In the same vein, air transport is appropriate for high value or urgent goods whilst sea transport is required for

heavy bulk load involving oil and timber whereas pipelines is suitable for petroleum and chemicals products which an organisation must consider in the global supply chain. For long haul perspective, rail is preferred to road as often cheaper; nevertheless, some organisations have beset the service issues which is significant to some customers to switch from rail to road as a result of afterwards service interruption suffering (Rushton et al., 2010).

## CONCLUSIONS

The aim of this paper was to critically evaluate the impact of multimodal, or intermodal choice on any organisation's sustainable supply chain strategies. The success of organisation depends on effectiveness of their global supply chain multimodal choice, that must consider the externalities factors (Meixell and Norbis, 2008), sustainability through triple bottom line (Elkintong, 2004) and trade- offs on transport modes (Rushton et al., 2010), which learned that, by so doing will lead the global supply chain for cost saving for the stakeholders (Bereford et al., 2011; 2009; Meixell and Norbis, 2008).

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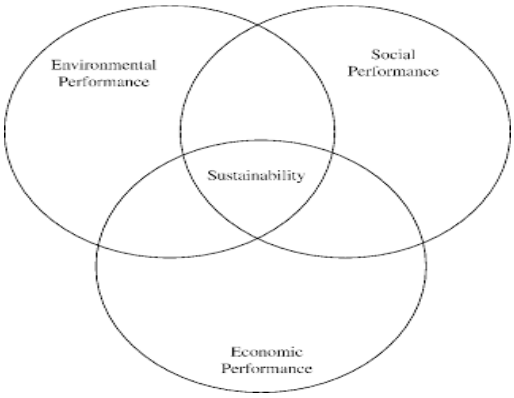
**Appendix 1**




**(Adapted: Carter & Rogers, 2008 Sustainability: The Triple Bottom Line)**

**Appendix 2**

| | | | | | |
|---|---|---|---|---|---|
| | 100T | Road | Road/rail | Rail/sea | Sea |
| **Size of order/load** | 20T | Road | Road | Road/rail | Rail/sea |
| | Pallet | Road | Road | Road/rail | Air/sea |
| | Parcel | Post/road | Post/road/air | Post/road/air | Post/air |
| | | Short | Medium | Long | Very long |
| | | | **Delivery distance** | | |

(Source: Adapted; Rushton, Croucher and Baker, 2010, Modal Choice Matrix)

**Appendix 3**

| | | | **Mode Of Transport** | | |
|---|---|---|---|---|---|
| **Operating Characteristics** | **Road** | **Rail** | **Air** | **Water** | **Pipeline** |
| Speed | 2 | 3 | 1 | 4 | 5 |
| Availability | 1 | 2 | 3 | 4 | 5 |
| Dependability | 2 | 3 | 5 | 4 | 1 |
| Capability | 3 | 2 | 5 | 4 | 1 |
| Flexibility | 1 | 3 | 5 | 2 | 5 |
| Environmental | 5 | 3 | 4 | 1 | 1 |
| Composite | 14 | 16 | 23 | 19 | 18 |

(**Source**: Lyson& Gillingham, 2003, Operating characteristics of five transport modes)

**Appendix 4**

| **Mode of Transport** | **Suitable for** | **Fixed Cost** | **Variable Cost** |
|---|---|---|---|
| Road | Medium/light loads | Low | Medium |
| Rail | Heavy bulk loads | High | Low |
| Air | High value goods where rapid delivery is important | Low | High |
| Water | Heavy bulk loads including oil & timber | Medium | Low |
| Pipelines | Petroleum, chemicals | High | Low |

(**Source**: Lyson& Gillingham, 2003, Fixed and Variable Costs of Differing Transport Modes)